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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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EXAMINER

SONG, MATTHEW J

ART UNIT	PAPER NUMBER
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1792

NOTIFICATION DATE	DELIVERY MODE
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11/18/2008

ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

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Office Action Summary	Application No. 10/678,766	Applicant(s) TOIS ET AL.	
	Examiner MATTHEW J. SONG	Art Unit 1792	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 24 July 2008.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1,3-24 and 26-39 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1,3-24 and 26-39 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
- ☐ Certified copies of the priority documents have been received.
 - ☐ Certified copies of the priority documents have been received in Application No. _____.
 - ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|--|---|
| 1) <input type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413) |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | Paper No(s)/Mail Date. _____ |
| 3) <input checked="" type="checkbox"/> Information Disclosure Statement(s) (PTO/SB/08) | 5) <input type="checkbox"/> Notice of Informal Patent Application |
| Paper No(s)/Mail Date <u>1/9/2008</u> . | 6) <input type="checkbox"/> Other: _____ |

DETAILED ACTION

Claim Rejections - 35 USC § 103

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

2. Claims 1, 3-9, 11-24, and 26-39 are rejected under 35 U.S.C. 103(a) as being unpatentable over George et al ("Surface Chemistry for Atomic Layer Growth") in view of Sandhu et al (US 6,313,035), Leskela et al (Journal De Physique IV for IDS filed 10/31/2007); and Suntola et al (US 6,015,590).

George et al discloses a method of atomic layer growth of SiO₂ using SiCl₄ and H₂O in an atomic layer epitaxial method. George et al also discloses deposition of other oxides such as Al₂O₃, SnO₂, TiO₂, ZrO₂, In₂O₃, and HfO₂ (pg 13122). George et al also discloses The surface functional groups also provide the technical means to alternate between various materials with

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atomic layer control and form superlattices (pg 13131), this clearly suggests applicants' multicomponent mixed oxide thin film because applicant's teach that a multicomponent film is achieved by growing some other oxide onto the growth substrate between silicon dioxide growth cycles, note paragraph [0041] of the published specification in US 2004/0065253. George et al discloses repeating A and B reactions to form a desired layer (pg 13124), this reads on applicant's plurality of deposition cycles.

George et al does not disclose a multicomponent thin film comprising silicon and a transitional metal. George et al discloses ALE for a variety of oxide materials including SiO_2 and Al_2O_3 , SnO_2 , TiO_2 , ZrO_2 , In_2O_3 , and HfO_2 .

In a method of forming a multicomponent oxide layer, note entire reference, Sandhu et al teaches a multi-component oxide layer comprises a mixture of a metal oxide and silicon oxide, specifically a silicon oxide and titanium oxide (claims 1 and 3). Sandhu et al also teaches the multi-component layer may be formed using CVD and may also be deposited using other processes (Abstract). Sandhu et al teaches the titanium silicon oxide layer may be used in a memory cell, as a capacitor oxide or other semiconductor devices or structures (col 8, ln 1-35). Sandhu et also teaches other combinations of dielectric and metals can be used. (col 8, ln 1-35).

Therefore, it would have been obvious to a person of ordinary skill in the art at the time of the invention to modify George et al by selecting silicon dioxide and Al_2O_3 , SnO_2 , TiO_2 , ZrO_2 , In_2O_3 , or HfO_2 because a mixture of a metal oxide and a silicon oxide to form a useful multi-component oxide layer which can be used to manufacture a useful semiconductor device, as taught by Sandhu et al (col 8, ln 1-65).

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The combination of George et al and Sandhu et al does not teach a plurality of consecutive deposition cycles that each deposit only a MSiO_x .

Leskela et al teaches ternary metal oxides by ALE formed by pulsing the precursors in a sequence corresponding to the stoichiometry. (C5-946), this clearly suggest applicant's plurality of consecutive deposition cycles that each deposit only a MSiO_x because only M, Si and O are used in the deposition, where M is A1, Si is A2 and O is B, based on the reactants taught by George et al.

It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of George et al and Sandhu et al by using a 1:1 ratio to produce a ternary oxide having a desired stoichiometry, as taught by Leskela et al. The combination of George et al, Sandhu et al and Leskela et al does not teach purging the reactor with an inert gas after each pulsing.

In a method of growing thin films using atomic layer epitaxy, Suntola et al teaches an interval between reactant pulses for evacuation of the entire gas volume in an apparatus during the interval between two successive reactant pulses and an inactive gas, this reads on applicant's inert gas, may be advantageously introduced to the reaction space during the evacuation (col 11, ln 20-40).

It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of George et al, Sandhu et al and Leskela et al by purging the reactor with an inactive gas to prevent CVD film growth conditions, which are detrimental in an atomic layer epitaxy process (col 7, ln 50 to col 8, ln 20), as taught by Suntola et al.

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Referring to claim 2, George et al teaches the growth rate is dependent on the number of reaction cycles (pg 13127), this clearly suggests applicant's process is repeated to form a layer of a desired thickness.

Referring to claim 3-7, George et al teaches using SiCl_4 , HfCl_4 and H_2O as reactants (pg 13122).

Referring to claim 8-9, George et al teaches deposition at 600 K ($\sim 327^\circ\text{C}$) (pg 13123).

Referring to claim 11-12, George et al teaches groove material with flat portions (Figure 1).

Referring to claim 13, George et al teach the deposition of dielectric films on trench or stacked capacitors for DRAM high storage memory (pg 13130) and Sandhu et al teaches forming a variety of semiconductor devices (col 8, ln 20-30); therefore forming on an electrode to form a semiconductor device would have been obvious to one of ordinary skill in the art.

Referring to claim 14-15, George et al teaches a superlattice structure formed by alternating various materials, which include HfO_2 , TiO_2 , Al_2O_3 and ZrO_2 (pg 13122 and 13131).

Referring to claim 16-18, George et al teaches SiO_2 gate oxides in MOSFET devices (pg 13121 col 1), deposition on a silicon surface (pg 13123 col 1) and the deposition higher dielectric gate oxide materials, such as TiO_2 and Al_2O_3 (pg 13130 col 2).

Referring to claims 19-20, combination of George et al, Sandhu et al, Leskela et al and Suntola et al teaches pulsing reactants to produce a desired stoichiometry, this clearly suggests using different ratios (Leskela et al pg C5-946).

Referring to claim 22, the combination of George et al, Sandhu et al, Leskela et al and Suntola et al teaches forming silicon oxide by pulsing a silicon compound followed by H_2O ,

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forming a metal compound by pulsing a metal compound followed by H₂O (George pg 13122) and purging the reactor between reactant pulses ('590 col 11, ln 30-40) to form a superlattice of various materials (pg 13131).

Referring to claim 24, the combination of George et al, Sandhu et al, Leskela et al and Suntola et al teach self-limiting reactions (George et al Abstract).

Referring to claim 34-35, a cycle is a relative term and thus can be defined to include multiple layer depositions, i.e. a cycle can be defined to be two silicon oxide layer and two metal oxide layers. The combination of George et al, Sandhu et al, Leskela et al and Suntola et al clearly suggest a cycle of Si→oxygen→metal→oxygen→Si→oxygen→metal→oxygen, which includes multiple silicon and first reactants a plurality of times in a cycle.

Referring to claim 36-39, the combination of George et al, Sandhu et al, Usui and Suntola et al teaches a similar method of alternating silicon and metal oxide deposition. The combination of George et al, Sandhu et al, Usui and Suntola et al does not teach the growth rate of the MSiO_x is higher than the rate of ALD of the metal oxide and silicon oxide from which the metal oxide is formed. This limitation is directed to an effect of the process; therefore the effect of increased growth rate is expected because a similar method is expected to produce similar results.

3. Claim 10 is rejected under 35 U.S.C. 103(a) as being unpatentable over George et al ("Surface Chemistry for Atomic Layer Growth") in view of Sandhu et al (US 6,313,035), Leskela et al (Journal De Physique IV for IDS filed 10/31/2007);and Suntola et al (US 6,015,590) as applied to claims 1, 3-9, 11-24, and 26-39 above, and further in view of Lowrey et al (US 5,891,744).

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The combination of George et al, Sandhu et al, Leskela et al and Suntola et al ('590) teach all of the limitations of claim 10, as discussed previously, except the thin multicomponent oxide is formed on a hemispherical grain structure.

In a method of monitoring the effects of hemispherical grains, Lowrey et al teach the capacitance of a polysilicon layer can be increased by increasing surface roughness of the polysilicon film and one type of polysilicon film, which maximizes a roughness of an outer surface is hemispherical grain polysilicon (col 1, ln 10-67). Lowery et al also teaches deposition of a dielectric on a hemispherical grain area, which forms a capacitor (col 4, ln 1-15).

The combination of George et al, Sandhu et al, Leskela et al and Suntola et al ('590) teach the deposition of dielectric films on trench or stacked capacitors for DRAM high storage memory (George pg 13130 col 2). Therefore, it would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of George et al, Sandhu et al, Leskela et al and Suntola et al ('590) by deposition the dielectric layer on a substrate having a hemispherical grain, as taught by Lowery et al, to enhance the capacitance of the capacitor.

Response to Arguments

4. Applicant's arguments filed 7/24/2008 have been fully considered but they are not persuasive.

In response to applicant's argument that there is no suggestion to combine the references, the examiner recognizes that obviousness can only be established by combining or modifying the teachings of the prior art to produce the claimed invention where there is some teaching, suggestion, or motivation to do so found either in the references themselves or in the knowledge

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generally available to one of ordinary skill in the art. See *In re Fine*, 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988) and *In re Jones*, 958 F.2d 347, 21 USPQ2d 1941 (Fed. Cir. 1992). Applicant alleges that there is not motivation to form the CVD films taught by Sandhu et al using the ALD process taught by George et al. The rejection is George in view of Sandhu, not Sandhu in view of George. George discloses a process for forming semiconductor films. Therefore, the relevant question is whether one of ordinary skill in the art would have found it obvious to modify George to produce a multicomponent material. In this case, George et al teaches method capable of producing a multicomponent compound taught by Sandhu et al to be a useful dielectric compound in semiconductor manufacturing (Abstract); therefore producing the material taught by Sandhu et al would have been obvious to one of ordinary skill in the art at the time of the invention.

Applicant's argument that the Examiner has not pointed out what semiconductor device would result from the combination of Sandhu and George is noted but not found persuasive. George discloses a method of semiconductor film deposition. Sandhu et al teaches multicomponent oxide can be used to manufacture dielectric layer used in semiconductor devices (abstract). In particular, Sandhu teaches memory cells, capacitor oxides and transistor gate oxides etc. (col 8, ln 1-35). Clearly, multicomponent oxides can be used in a variety of semiconductor devices.

In response to applicant's argument that there is no suggestion to combine the references, the examiner recognizes that obviousness can only be established by combining or modifying the teachings of the prior art to produce the claimed invention where there is some teaching, suggestion, or motivation to do so found either in the references themselves or in the knowledge

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generally available to one of ordinary skill in the art. See *In re Fine*, 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988) and *In re Jones*, 958 F.2d 347, 21 USPQ2d 1941 (Fed. Cir. 1992). In this case, Leskela et al teaches producing ternary films using ALE and a ternary compound is prepared by pulsing the precursors in a sequence corresponding to the stoichiometry (C5-946). Therefore, It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of George et al and Sandhu et al's multicomponent (ternary) film by Leskela et al teaching of forming ternary compound by pulsing precursors in a sequence (a cycle) corresponding to the stoichiometry of the film to form the multicomponent film having the desired stoichiometry.

Applicant's argument that Leskela et al states the growth of ternary oxides by ALE is a challenge is noted but is not found persuasive. First, Leskela et al merely teaches "the growth of ternary oxides by ALE is a challenge because the achievement of correct stoichiometry is much more difficult than in the binary compounds." Leskela et al teaches the achievement of correct stoichiometry is more difficult, not that ternary oxide growth in general is more difficult. It is noted that applicant does not require films with exact stoichiometry and teach that the oxide is not always completely stoichiometric. (pg 9, ln 9-10). Second, Leskela merely teaches the ternary oxide growth is a challenge but also teaches successful ternary oxide growth has been achieved. (C5-946). Finally, Leskela may teach that ternary oxide growth is a challenge, however George et al teaches superlattice growth of different compounds of different compounds, the George et al suggests the growth of ternary compounds.

Applicant's argument regarding unexpected results is noted but not found persuasive. First, the claims is broad and recites any metal. Applicant's Page 9 of the specification notes only

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a threefold increase in growth rate for only La and Y, and using ozone and water as oxygen sources in Example 2. Therefore, the claims are not commensurate in scope with the evidence. Second, page 9 of the specification and Example 2 recites broadly the results without teaching the conditions (pulse length, purge length, temperature etc) for achieving the results; therefore no accurate comparison can be made. Applicant's Example 1 clearly illustrates that growth parameters affects growth rate, as a growth rate of 0.15 angstrom/cycle is achieved at a temperature of 300°C and 0.28 angstrom/cycle at a temperature of 200°C. Third, applicant merely alleges unexpected results without any comparison with the closest prior art, George et al. Applicant alleges a three fold increase from 0.2 angstroms/cycle for individual oxides to 0.7 angstroms/cycle for multicomponent oxides on page 9 of the specification, and growth rates ranging from 0.2 angstroms/cycle to 1.23 angstroms/cycle in Example 2 for multicomponent oxides. However, George et al teaches a SiO₂ ALE deposition with a growth rate of 1.1 angstrom/cycle (pg 13124 and Figure 5) and an Al₂O₃ ALE deposition with a growth of 1.1 angstrom/cycle (pg 13127 and Figure 12). Clearly, George et al teaches individual oxide growth rates in excess of the 0.2 angstroms/cycle reported by applicant, and growth rates equal to the values obtained by applicant for multicomponent oxide. Finally, ALE growth is comprised of a pair of half reactions and each reaction self terminates with the consumption of the initial function group (George et al pg 13123); therefore complete reactions for each reaction would be expected to produce a maximum growth rate of approximately 1.1 angstroms/cycle because George et al teaches complete half reactions and the 0.2 angstroms/cycle taught by applicant merely indicate incomplete half reactions for the individual oxides.

Conclusion

5. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

6. Any inquiry concerning this communication or earlier communications from the examiner should be directed to MATTHEW J. SONG whose telephone number is (571)272-1468. The examiner can normally be reached on M-F 9:00-5:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Michael Kornakov can be reached on 571-272-1303. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

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Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

Matthew J Song
Examiner
Art Unit 1792

MJS
November 9, 2008

/Robert M Kunemund/
Primary Examiner, Art Unit 1792